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EMISSION OF SECONDARY ELECTRONS AND IONS IN THE INTERACTION OF SLOW HIGHLY CHARGED IONS WITH SOLIDS

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We have measured the number of electrons emitted from surfaces at impact of slow ($v<0.4$ v_{Bohr}) ions as a function of projectile charge for $1+<q<75+$ (Fig. 1) [1]. Targets were SiO_2-films (150 nm on Si) and thin (~2-3 nm) hydrocarbon films on gold. Electron yields increase for both targets nearly linear with ion charge.
Total yields were determined from measured relative yields by use of previously measured absolute yields from gold [2]. Yields from the gold target increased by ~10% after in situ removal of the hydrocarbon layer.
Electron yields from the insulating film amount to only half of the yields from the gold target, reflecting an increase of the effective workfunction due to the production of holes with low mobility in the SiO_2-film.
TOF-SIMS spectra of negative secondary ions were recorded in parallel with secondary electron yields (Fig. 2-top). Yields of negative molecular ions increase strongly with projectile charge like $\sim q^n$, $n\approx 3$-4. $C_2H_x^-$-yields (detection efficiency of ~10% not included) are found to saturate for $q>60+$, indicating the complete removal of hydrocarbons from the interaction area.
Above a threshold for the onset of dominant electronic sputtering mechanisms, positive secondary ions from SiO_2 are found to outnumber negatives by a factor of three.
Electron emission results in local charging of the insulating film. Secondary ions are emitted as the Coulomb stress is relaxing. Plotting the number of secondary ions as a function of secondary electron emission shows a linear correlation of electron and ion emission (Fig.2 bot).

References:
[1] T. Schenkel, A. V. Barnes, M. A. Briere, A. Hamza, A. Schach von Wittenau, D. Schneider, NIM B, 1997, in press
[2] F. Aumayr, et al., PRL 71 (1993) 1943

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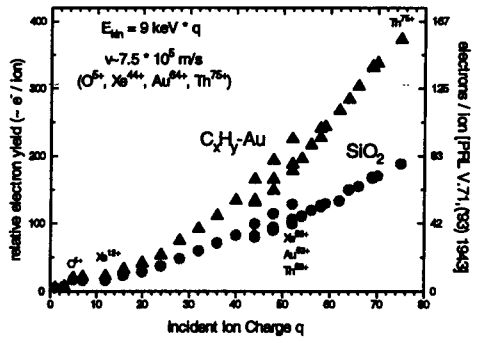
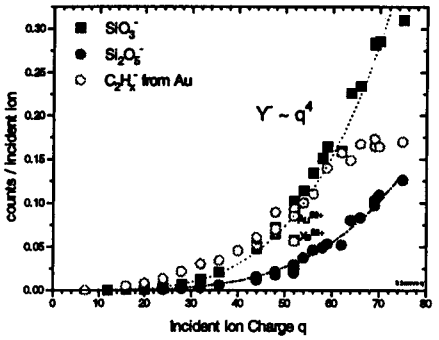


Fig. 1.: Electron emission from C_xH_y-Au and SiO_2 as a function of projectile charge state.



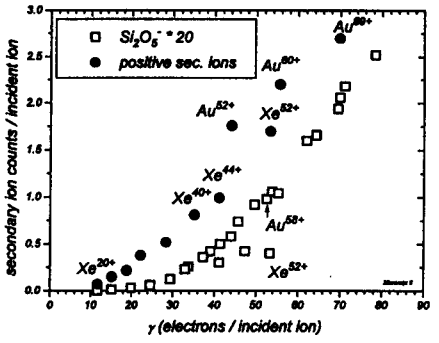


Fig. 2.: Charge dependent production of negative molecular ions from C_xH_y-Au and SiO_2 (top). Production of positive and negative ions from SiO_2 as a function of electron emission at highly charged ion impact (bottom).